Coherent Radio Bursts from RS CVn Binaries

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We present VLA observations of RS CVn binaries which indicate that the low–frequency polarization inversion usually ascribed to the quiescent radio emission of these systems is in fact due to the presence, much of the time, of a coherent burst emission. Figure 1 shows two examples of this coherent emission in the behaviour of the light curves of HR 1099 in left and right circular polarization at 1.4 GHz. The emission is highly circularly polarized, with one polarized component steady or slowly varying in a way similar to the higher frequency emission (Fig. 1a), while the other shows rapid fluctuations on timescales of ~ 10 s and a slower modulation on longer timescales. The similarity of the time profiles in two 50 MHz–wide sidebands 30 MHz apart indicates that the fluctuating component is broadband; moreover, the sense of polarization at 1.4 GHz is opposite to that of the quiescent emission (attributed to gyrosynchrotron emission) at higher frequencies, which is exactly the behaviour attributed to the 1.4 GHz quiescent emission of these systems by Mutel et al. (1987).

The rapid fluctuations and high polarization are characteristic of a coherent emission process. We argue that a combination of two sources of emission is generally present at 1.4 GHz: a very highly (possibly 100 %) polarized coherent component, and a weakly-polarized, steady gyrosynchrotron component. Since the polarization at higher frequencies should be the x-mode of (optically–thin) gyrosynchrotron emission, we infer that the low-frequency polarization probably represents the o-mode. The observed characteristics of the emission then suggest that the most likely mechanism for the highly-polarized component is plasma emission at the fundamental of the plasma frequency. Such plasma emission is relatively rare on the Sun at 1.4 GHz, but could occur in the hotter coronae of RS CVn systems because the higher temperature reduces the free–free opacity which is thought to absorb 1.4 GHz plasma emission on the Sun.

These observations suggest a different interpretation for the reversal in the sense of polarization at low frequencies previously attributed to the quiescent radio emission of RS CVn binary systems, which has proven very difficult to explain in terms of plausible gyrosynchrotron models (see White & Franciosini 1995). We propose that a coherent o-mode emission is frequently present also during low-activity periods, when it may be too weak to be distinguished from the gyrosynchrotron component. The gyrosynchrotron component is probably

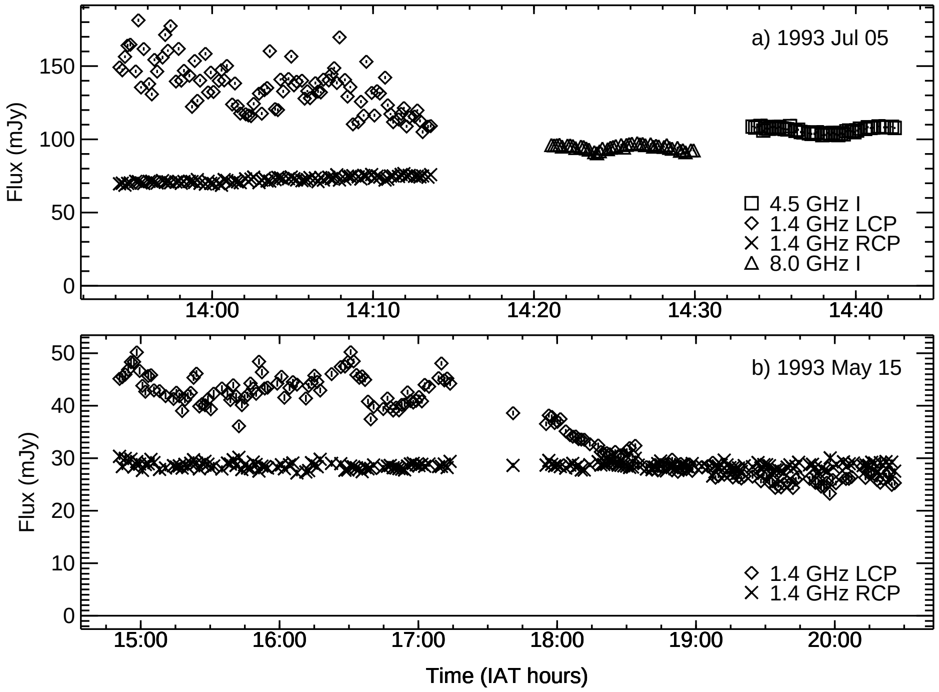

Fig. 1. The time profiles of right (R) and left (L) circular polarization at 1.4 GHz during a VLA observation of HR 1099 on 1993 July 5 (upper) and 1993 May 15 (lower). In the first case the total intensity (I) in subsequent scans at 4.5 GHz and 8.1 GHz is also plotted. Error bars of $\pm\sigma$ are plotted on all points

weakly polarized, so that the polarization of the integrated emission is dominated by the coherent component. We have some data suggesting that the true polarization of the quiescent emission at 1.4 GHz is in the sense of the x-mode as at higher frequencies. An example is shown in Fig. 1b, where the steady emission observed after the decay of the rapidly-varying coherent component is clearly polarized in the opposite sense.

The long duration of the observed coherent emission (20 m – several hours) together with the rapid variability ($\sim$ 10 s) suggest that there must be a continuous supply of energetic electrons to the source, which requires a continuous acceleration mechanism and therefore also a continuous energy release in the corona of these stars. Such emission may therefore be evidence for steady, rather than sporadic, sites of energy release in the coronae of active stars.

References

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